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HILAT/POLAR BEAR AND POLAR BEACON SATELLITE PROGRAM AT TROMSO, NORWAY

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COMMUNICATION SYSTEMS OF DIFFERENT KIND SUFFER DEGRADATION IN PERFORMANCE DUE TO PHASE AND INTENSITY SCINTILLATIONS IMPOSED BY THE IONOSPHERIC IRREGULARITIES OF ELECTRON DENSITY.
IN AN EFFORT TO STUDY PLASMA STRUCTURING, THE HILAT AND POLAR BEAR SATELLITES WERE LAUNCHED IN 1983 AND 1986.
TROMSØ SATELLITE STATION (69°39'N, 18°56'E) IS LOCATED WITHIN THE NIGHTIME AURORAL OVAL. BEACON AND TELEMETERED IN-SITU DATA FROM BOTH SATELLITES WERE RECORDED.
RAW BEACON DATA AS WELL AS THE TELEMETERED IN-SITU DATA AND ON-LINE PROCESSED SCINTILLATION STATISTICS ARE RECORDED ON RAW AND SUMMARY TAPES.

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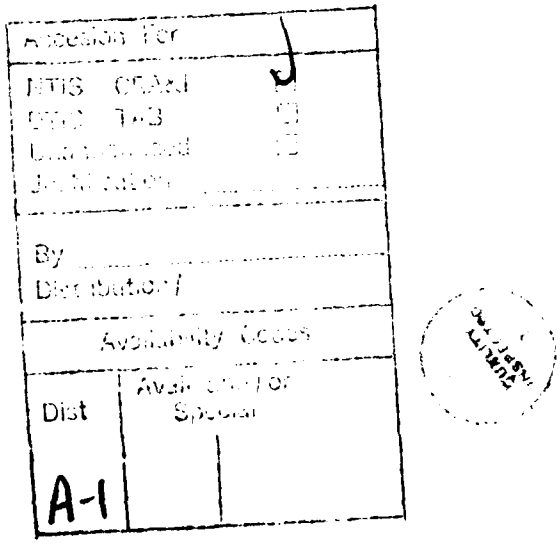
PREFACE

The author of this report want to acknowledge the carefully executed work done by the employees at Tromsø Satellite Station during the time the station has carried out HILAT/POLAR BEAR and AFSATCOM operations.



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SUMMARY

Tromsø Satellite Station (TSS) is located at 69° 39′ N, 18° 56′ E, which is close to an ideal location for receiving data from polar orbiting satellites.
The main operational tasks are receiving and processing data from the COSPAS/SARSAT system, which is concerned with location of emergency beacons via satellites, and data from the TIROS-N/NOAA series of satellites, i.e. earth observation data.

In addition TSS provides services and accomodation for various projects, among which HILAT/POLAR BEAR and AFSATCOM are important. TSS′ is located within the nightime auroral oval and measurements carried out as a part of this project has provided multi-frequency auroral scintillation data as a function of latitude and local time.
The proximity of the EISCAT radar and the German high power heater has allowed in-depth studies of natural and artificial irregularity generation.

TROMSØ SATELLITE STATION (TSS)

Tromsø Satellite Station is located in the town of Tromsø in the northern part of Norway. Around 40.000 people are living in Tromsø and the town is easily reached by commercial airlines. It has a very well developed harbour and is of course connected to the road system in Norway by roads of high standard. The geographical coordinates of Tromsø are 60° 39'N, 18° 56'E.

The station was established in 1966 by the Royal Norwegian Council for Scientific and Industrial Research, Space Activity Division. In the period from 1966 to 1974 the station worked on contract with the European Space Research Organization (ESRO) operating on the following scientific satellites launched by this organization:
ESRO-1A and B, ESRO-2, ESRO-4 and TD-1.

Tromsø Telemetry Station, as it then was called, was used both as data reception and TT&C facility under control of the European space operation Centre (ESOC) in Darmstadt, Germany.
Other projects the station has been involved in include the Canadian satellites Alouette and ISIS (1966-1970) and the French/U.S.S.R. satellite ARCAD (1980-1983).

In 1986 a governmental decision paved the way for a full member status for Norway in ESA from 1 January 1987. It was also decided that TSS should be expanded to become a national receiving station for the ESA satellite ERS-1. The station is now a part of the Norwegian Space Center.

In 1989 TSS moved into a new building which provides modern and easy-to-run facilities both for office purposes and for equipment installation.

Since 1974 TSS has been working with remote sensing satellites, in particular meteorological satellites in the TIROS-N/NOAA series. The station is able to utilize

data from three of the four instruments on board, namely the Advanced Very High Resolution Radiometer (AVHRR), the Data Collection System (DCS/ARGOS) and the TIROS Operational Vertical Sounder (TOVS).

COSPAS/SARSAT is an international system utilizing polar orbiting satellites to detect and locate emergency beacons. SARSAT is a joint program (USA, France and Canada) where the space segment is flying on board the TIROS satellites. COSPAS is the Soviet counterpart and is flying on board satellites in COSMOS series.
Norway is participating in the program by operating a Local User Terminal (LUT) at TSS.

Each participating country in ESA operates a National Point of Contact (NPOC) which is responsible for distribution of data from ESA/Earthnet. Primarily this has been data from the LANDSAT satellites, but also data from experimental satellite missions is distributed.
From 1987 ESA/Earthnet started a program for co-ordinated archiving and distribution of AVHRR-data to the European scientific user community. On a contract with Earthnet TSS is a vital part of this program.
Under the same contract with Earthnet, TSS is receiving and archiving MSR-data from the Japanese MOS-1 satellite.

From 1982 up to the end of 1990 TSS has been involved in a project with U.S Air Force Geophysics Laboratory (AFGL) receiving data from the HILAT/Polar Bear satellites. This is a scientific satellite program.

TSS has also offered services and facilities for various field experiments, like MIZEX and CEAREX. These are experiments working along the marginal ice zone between Svalbard and Greenland and the Barents Sea. TSS has provided satellite data and other assistance, like offices and telecommunication arrangement for coordination of the activities.
Also facilities for processing of satellite images have been provided.

One of TSS's main goals is to establish itself as a reliable near-realtime source of satellite remote sensing data.
As pointed out above, data from the NOAA satellites has been the principal source. However, the aim for all the current activities is to be well prepared when satellites with imaging radars on board will in orbit from the beginning of the 1990-ties.
To accomplish this goal, various projects are under way. and the following is a list of the most important ones.

Near-realtime dissemination of AVHRR-data using terrestial data network. Both quick-look imagery, raw data and pre-processed data is made available for direct access to users via data network.

In close connection to the above described project is development of a catalog and order handling system.

The major project up to mid-1991 is to expand TSS to be able to receive, process and disseminate data from ESA's ERS-1 satellite. This is a national enterprise and main emphasis will be put on near-realtime processing and dissemination of SAR-data (Synthetic Aperture Radar). The major component will be a Norwegian developed SAR-processors. In co-operation with UK, ESA and Norway, development and validation of a processing system for ATSR-data (Along Track Scanning Radiometer) from ERS-1 is being done.

In order to be able to disseminate SAR-data in near-realtime a satellite based 2 Mbs data communication project is realized. This is a multi-cast system utilizing NORSAT-B, which is a satellite telecommunication system established by the Norwegian Telecommunication Administration.

TSS' location at a high latitude is close to ideal position for auroral research with respect to polar orbiting satellites. Out of a total of 14 passes per day (800 km orbiting altitude) 10 passes are seen from Tromsø. This situation may be further improved

when taking into account the possibility of establishing a station on Svalbard (78° - 80° N) where all passes will be seen.

The described advantages with easy accessible high latitude location for data reception as well as for TT&C (Tracking, Telecommand and Control) purposes is one of the most obvious benefits TSS can offer and contact is established with both instrument and satellite owners who might be interested in our services.

HILAT, POLAR BEAR AND POLAR BEACON SATELLITE STUDIES AT TROMSØ.

A wide variety of communication systems suffer degradiation in performance due to phase and intensity scintillation imposed by the ionospheric irregularities of electron density. There is a great deal of interest in understanding the development of such irregularities at high latitudes where the ionosphere is often strongly coupled with the magnetosphere. In such an environment the distant magnetosphere serves to activate different sources of free enegy, for example, electron precipitation, field-aligned currents, electric fields, and so on, that control the formation of ionospheric irregularities. No longer is it possible to pursue a study of the irregularity devlopment in the local ionospheric environment without considering the coupling between the ionosphere and the magnetosphere. This approach is particulary useful in extrapolating our knowledge of natural ionospheric irregularity structures to problems related to the structuring of artificially injected plasma clouds in the high latitude inonosphere.

In an effort to study plasma structuring in the above context, the Hilat satellite was launched on 27 June 1983, in a circular 830-km orbit at 82° inclination. The satellite transmits coherent signals at 137, 390, 413 and 436 MHz and the phase reference signal at 1239 MHz to measure complex signal scintillation and total electron content (TEC). It also carries a variety of in-situ probes providing measurements of ion

density, ion drift, energetic electron precipitation, field-aligned currents, and emission at two visible wavelengths.

In November 1986, the Polar Bear satellite was launched in a circular 1000-km polar orbit. The satellite is equipped with a beacon package identical to that of the Hilat satellite and a magnetometer and UV imager.

Computer controlled receiver and tracking antenna systems can record the beacon and the telemetered in-situ data from both satellites. Raw beacon data as well as the telemetered in-situ data and on-line processed scintillation statistics are recorded on raw and summary tapes.

The Tromsø Satellite Station (69° 39′ N, 19° 56′ E) is located within the nighttime auroral oval. The measurements detailed above will provide multi-frequency auroral scintillation data as a function of latitude and local time. The enhanced scintillation activity during the current near solar maximum period will be able to define the scintillatin boundary and the daytime trough. In addition, polar beacon satellite will be monitored around the clock to provide auroral scintillation morphology. The proximity of the EISCAT radar and the German high power heater will allow in-depth studies of natural and artificial irregularity generation.
In order to achieve the above, the work to be perfomed is outlined in the next section.

TASKS PERFORMED AT TROMSØ SATELLITE STATION

Tromsø Satellite Station has performed several tasks during the grant period.
TSS has provided technician services to operate, record and calibrate scientific data from the following satellites.

DNA-HILAT/POLAR BEAR
AFSATCOM

According to given schedule the equipment has been set up to receive satellite data. In addition off-line computer runs for data from the satellites has been performed.
Calibration has been done each normal working day on each recorder channel.

In addition to operation, maintenance activites has been performed as necessary to the extent of replacing components within the system. Maintenance and replacing of equipment has been carried out in close co-operation with the equipment vendor. In cases when it has been impractical to repair on site, assemblies or sub-assemblies has been returned according to instructions from AFGL.

To the extend necessary TSS has purchased expandable supplies like magnetic tape from local vendors.

All digital tape recordings and analog chart recordings has been sent bi-weekly via air mail to AFGL.
When the grant period ended all equipment has been sent back U. S.A. according to instructions.

EQUIPMENT PROVIDED BY AFGL OR ITS SUBCONTRACTOR

The following equipment has been used at TSS for the purpose of executing the tasks described above.

HILAT/POLAR BEAR SATELLITE

- Two main UHF- and L-band tracking antennas
- One main VHF omni-directional antenna
- Two remote UHF tracking antennas with cables to carry 220 V at low power
- Three racks of equipment including receivers and an HP series computer

AFSATCOM

Phase receiver

Three pairs of remotely located UHF fixed antennas located near the satellites HILAT/POLAR BEAR UHF antennas, including low voltage power for RF preamplifiers.

Equipment consisting of one rack containing the receiver and computer plus keyboard and display.

Total Power Receiver

One pair of fixed Yagi antennas with connecting cables.

Equipment consisting of one rack containing the receivers, calibrator and chart recorder.